



## Barriers and facilitators to hepatitis B vaccination among sex workers in Vancouver, Canada: Implications for integrated HIV, STI, and viral hepatitis services



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### ABSTRACT

**Objectives:** Sex workers (SWs) face an increased burden of sexually transmitted and blood-borne infections, yet little is known regarding hepatitis B virus (HBV) prevention and care. This study was performed to characterize cross-sectional and prospective correlates of HBV vaccination among SWs in Vancouver.

**Methods:** Questionnaire data were drawn from a community-based cohort of SWs (2010–2017). Multivariable logistic regression was used to examine correlates of lifetime self-reported HBV vaccination. Multivariable generalized estimating equation (GEE) regression was used to assess correlates of recent vaccination.

**Results:** Among 855 participants, 68.3% reported lifetime HBV vaccination. Multivariable logistic regression showed that im/migrants (adjusted odds ratio (AOR) 0.50, 95% confidence interval (CI) 0.32–0.78) had lower odds of vaccination and that those using injection drugs (AOR 1.88, 95% CI 1.27–2.78) and those who had undergone HIV testing (AOR 1.94, 95% CI 1.14–3.29) had higher odds of vaccination. In the multivariable GEE analysis, HIV seropositivity (AOR 1.93, 95% CI 1.26–2.97) and recent STI testing (AOR 2.95, 95% CI 1.99–4.39) correlated with recent HBV vaccination.

**Conclusions:** Im/migrant SWs from HBV-endemic settings appear to face gaps in HBV prevention. Evidence-based interventions addressing gaps in voluntary HBV prevention and care are needed, including community-based and culturally safe services. Injection drug use and HIV testing were linked to enhanced vaccination, suggesting that harm reduction and HIV programmes may facilitate linkage to HBV prevention.

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### Introduction

Women sex workers face disproportionate social and health inequities, including those related to HIV and other sexually transmitted and blood-borne infections (STBBIs). These include risks conferred through unsafe work and living environments (Lazarus et al., 2011; Reed et al., 2011; Goldenberg et al., 2015a), higher rates of structural violence (criminalization, policing)

(Shannon et al., 2008, 2015; Goldenberg et al., 2016), economic insecurity (Benoit and Millar, 2001), poor sexual health (Benoit and Millar 2001; Cohan 2006), and reduced access to healthcare services (Lazarus et al., 2012; Mtetwa et al., 2013; Deering et al., 2015; Socías et al., 2016). The disproportionate burden of STBBIs faced by sex workers varies globally in prevalence due to social, political, economic, and cultural factors (Shannon and Csete, 2010). Despite increased efforts to evaluate and address inequities in STBBIs amongst sex workers, women who engage in sex work remain a persistently underserved population, with critical gaps in knowledge related to specific STBBIs, including hepatitis B virus (HBV).

HBV causes a viral infection of the liver and is transmitted through contact with blood or other body fluids. Beyond acute

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infection, which may last a few weeks, HBV has the potential for chronic sequelae, including cirrhosis and liver cancer, and may thus contribute to increased morbidity and mortality (World Health Organisation, 2013). In recent years, there have been major advancements in hepatitis C virus (HCV) treatment regimens, and while there is growing momentum towards finding a cure for HBV (2018), vaccination remains the cornerstone of prevention efforts.

Given the multiple potential routes of HBV transmission (sexual transmission, needle sharing) (Franco et al., 2012; World Health Organisation, 2013), HBV has been identified as an important potential health risk for several groups of marginalized women, including homeless women (Beech et al., 2002), women who use drugs (Nielsen et al., 2016; Haussig et al., 2018), and women living with HIV (CDC, 2014). However, few studies on STBBIs within the context of sex work have included assessments of the burden of HBV or the uptake of vaccination or other HBV-related services amongst sex workers (Mak et al., 2003; Baars et al., 2009; Carneiro et al., 2014; Magalhães et al., 2017). In Canada, many sex workers face the potential for elevated HBV exposure through both sexual and drug-related pathways (Goldenberg et al., 2017c). In in-call sex work environments in Vancouver, as well as in similar settings in Canada and the USA, there is a significant representation of im/migrants from HBV-endemic countries, where rates of vertical transmission of HBV remain high (World Health Organisation, 2013). Yet, very few studies have looked at the need for and experiences accessing HBV prevention, testing, treatment and care among sex workers, including engagement in vaccination.

Previously published theoretical frameworks have highlighted the central role of structural determinants of STBBIs, including HIV (Shannon et al., 2014), although structural factors have less often been the focus of research on HBV prevention. The present study drew on this conceptual work to consider the ways in which structural-level and community/work environment-level factors may act dynamically with individual-level factors to confer varying degrees of risk and protection that shape HBV vaccination access among sex workers. For example, prior work suggests that im/migrant workers may face unique barriers to STBBI prevention and care due to stigma, language barriers, unfamiliarity with sex work laws, fear of exposure, and discriminatory/racialized treatment by law enforcement (Anderson et al., 2015; Deering et al., 2015; Goldenberg et al., 2017b). Importantly, in Vancouver, racialized im/migrants from HBV-endemic countries of East and Southeast Asia are greatly overrepresented within in-call sex work venues such as massage parlours (Goldenberg et al., 2015b). Health access, including access to support such as sexually transmitted infection (STI) testing, has also been shown to facilitate linkage to ancillary care such as viral hepatitis services for marginalized populations of people who use drugs (CDC, 2012). Furthermore, important links have also been demonstrated between uptake of peer outreach and sex worker-specific services and sexual and reproductive health access (Kim et al., 2015). Finally, individual-level factors such as age can influence whether participants were eligible for infant/childhood HBV vaccination campaigns, depending on the date of programme implementation.

Previous studies in Metro Vancouver, British Columbia (BC), have explored the sexual and drug-related transmission pathways of viral hepatitis among women sex workers; however this work has focused primarily on HCV epidemiology (Goldenberg et al., 2017c). There remains a dearth of data describing HBV risk and prevention, and as a result much is unknown about the burden of HBV-related disease among women sex workers. Given gaps in evidence regarding access to HBV prevention, treatment, and care in this underserved population, the aim of this study was to characterize cross-sectional and prospective correlates of self-reported HBV vaccination amongst a community-based cohort of women sex workers in Metro Vancouver, BC.

## Methods

Data for this study were drawn from an open prospective cohort, An Evaluation of Sex Workers Health Access (AESHA) that initiated recruitment in late January 2010. This study was developed based on substantial community collaboration with sex work agencies since 2005 and continues to be monitored by a community advisory board of representatives of 15+ community agencies. Experiential staff (i.e., current/former sex workers) are represented across interviewer, outreach, and nursing teams. Current eligibility criteria include self-identifying as female (including both cis and trans women), exchanged sex for money within the last 30 days, and providing written informed consent. Time–location sampling was used to recruit sex workers aged 14 years and older through day and late night outreach to outdoor/public sex work locations (i.e. streets, alleys) and indoor sex work venues (i.e., massage parlours, micro-brothels, and informal indoor spaces such as bars, housing, and hotels) across Metro Vancouver. Online recruitment was used to reach sex workers working through online solicitation spaces. Indoor sex work venues and outdoor solicitation spaces are identified through ongoing community mapping conducted together with current/former sex workers and continue to be updated by the outreach team (Goldenberg et al., 2017a).

At enrolment and on a bi-annual basis, participants completed an interview-administered questionnaire by a trained interviewer and HIV/STI/HCV serology testing by a project nurse. The main interview questionnaire elicited responses related to socio-demographic characteristics, sex work patterns, drug use patterns of sex workers and their clients, physical work environment factors, social/interpersonal environment factors, and structural environment factors. Sex workers visited one of two storefront offices in Metro Vancouver to complete the questionnaire and nursing component, or had the option of completing the visit at their work/home location. All participants received an honorarium of \$40 CAD at each visit for their time, expertise, and travel. All participants received pre and post-test counselling, and nursing staff provided referral and active connections to service providers (e.g., mental health services, HIV providers, STI treatment). The study holds ethical approval through Providence Health Care/University of British Columbia and Simon Fraser University Research Ethics Boards (REB # H09-02803).

## Variables

For the main analysis, the dependent variable – self-reported HBV vaccination – was defined as reporting ever having been vaccinated for HBV. For sub-analysis, the dependent variable was a time-updated measure of self-reported HBV vaccination in the last 6 months, which was evaluated at each bi-annual follow-up visit.

Based on our adapted structural determinants framework (Shannon et al., 2014), the main analysis looked at independent variables of interest exploring individual-, healthcare access-, and structural-level factors. Variable selection was based on the literature and previously published AESHA data, and included factors hypothesized to be linked to HBV vaccination and health and/or safety for sex workers (Mak et al., 2003; Baars et al., 2009; Carneiro et al., 2014; Anderson et al., 2015; Deering et al., 2015; Goldenberg et al., 2017b; Magalhães et al., 2017). Individual-level characteristics included age, HIV seropositivity (assessed through voluntary bioLytical INSTI rapid tests for HIV screening), identifying as a gender and/or sexual minority (defined as ‘yes’ to any of gay, lesbian, bisexual, queer, two spirit, asexual, transgender, intersex, transsexual, genderqueer, other), ethnicity (categorized as white, indigenous, or other minority), and injection and non-injection illicit drug use (e.g., crack cocaine, crystal meth, heroin,

diversion of prescription opiates). Structural factors included whether or not the participant was an im/migrant to Canada, time since migration to Canada ( $\leq 5$  years vs.  $> 5$  years) (Sou et al., 2017), and country of birth (categorized as Canada, non-HBV-endemic country, or HBV-endemic country). Healthcare access factors studied included ever having used sexual and reproductive health (SRH) services in Vancouver, and engagement in HCV, STI, and HIV testing.

For sub-analysis, independent variables postulated to be related to vaccination access over time were examined. Time-fixed variables included age at baseline, HIV seropositivity, identifying as a gender and/or sexual minority, and being an im/migrant to Canada. Other variables were assessed as recent exposures during the past 6 months (e.g., injection drug use, primary place soliciting clients, primary place servicing clients, used SRH services, STI, HIV, and HCV testing), which were time-updated at each bi-annual follow-up.

### Statistical analyses

The baseline analysis of lifetime self-reported HBV vaccination was conducted among 855 participants enrolled in the study between January 2010 and February 2017. Frequencies and proportions for categorical data, as well as the median and interquartile range (IQR) for continuous data were calculated, stratified by self-reported lifetime HBV vaccination status. Differences between participants who self-reported HBV vaccination and those who did not were assessed using the Wilcoxon rank sum test for continuous variables and Pearson's Chi-square test (or Fisher's exact test for small cell counts) for categorical variables. Correlates of self-reported lifetime HBV vaccination status at baseline were examined using bivariate and multivariable logistic regression. Variables that were a priori hypothesized to be related to HBV vaccination and which were significant at  $p < 0.05$  in bivariate analyses were considered for inclusion in the multivariable model. Model selection was performed using a manual backward stepwise selection approach. The Akaike information criterion (AIC) was used to determine the best fitting and most parsimonious model, as indicated by the lowest AIC value. Analyses were performed using SAS software version 9.4 (SAS, Cary, NC, USA). A complete case approach was used such that any observations with missing data were excluded. All tests of significance were two-sided, and a  $p$ -value of 0.05 or less was selected for defining statistical significance.

For the sub-analysis of self-reported HBV vaccination in the last 6 months, logistic regression with generalized estimating equations (GEE) and an exchangeable correlation structure was used. Bivariate and multivariable GEE analyses included all follow-up data during the study period, accounting for repeated measures amongst participants.

### Results

Baseline analyses were based on 855 participants, of whom 584 (68.3%) self-reported lifetime vaccination for HBV. One hundred and eleven participants (15.8%) reported HBV vaccination in the last 6 months during the study period. At baseline, the median age was 35 years (IQR 28–42 years). Over one third (36.3%) of the women self-identified as indigenous and 25.3% were most comfortable speaking a language other than English. Close to one third (28.7%) of women were im/migrants born outside of Canada, with 10.6% of the cohort being recent im/migrants ( $\leq 5$  years in Canada) and 15.8% being long-term im/migrants ( $> 5$  years in Canada). Among im/migrant women, the median time since migration to Canada was 6 years (IQR 3–11 years), and the vast majority (89.8%) were from HBV-endemic countries, primarily China (78.4%).

In the bivariate analysis (Table 1), HIV seropositivity (odds ratio (OR) 2.26, 95% confidence interval (CI) 1.39–3.68), non-injection drug use (OR 2.95, 95% CI 2.14–4.07), and injection drug use (OR 2.82, 95% CI 2.09–3.81) were all correlated with increased odds of self-reported HBV vaccination. Im/migrants to Canada (OR 0.29, 95% CI 0.21–0.40), those born in HBV-endemic countries (OR 0.28, 95% CI 0.20–0.38), and ethnic minorities (OR 0.35, 95% CI 0.25–0.51) had lower odds of being vaccinated. Healthcare access factors such as utilization of SRH services (OR 1.98, 95% CI 1.46–2.68) and having received HCV (OR 3.59, 95% CI 2.56–5.05), STI (OR 2.81, 95% CI 1.83–4.32), or HIV testing (OR 3.65, 95% CI 2.35–5.67) prior to enrolment were all associated with higher odds of self-reported HBV vaccination.

In the multivariable analysis of lifetime HBV vaccination, im/migrants to Canada (adjusted odds ratio (AOR) 0.50, 95% CI 0.32–0.78) had significantly lower odds of self-reported HBV vaccination, whereas those with a lifetime history of injection drug use (AOR 1.88, 95% CI 1.27–2.78) and those who had received HIV testing prior to enrolment (AOR 1.94, 95% CI 1.14–3.29) were more likely to self-report vaccination (Table 2).

In the multivariable GEE sub-analyses of recent HBV vaccination during the study period ( $n = 703$ , 4137 observations), HIV seropositivity (AOR 1.93, 95% CI 1.26–2.97) and recent STI testing (AOR 2.95, 95% CI 1.99–4.39) were significantly correlated with recent self-reported HBV vaccination over the 7-year study period (Table 3).

### Discussion

Although there remains a dearth of research on viral hepatitis among marginalized populations of women, including women sex workers, some previous efforts have been undertaken to determine HBV vaccination coverage rates of sex workers. In the present study, 68.3% of participants self-reported ever being vaccinated for HBV – a statistic that is similar to those reported in studies on sex workers in Belgium, England, and the Netherlands, which reported HBV vaccination rates of 67.9%, 59.8%, and 52.0%, respectively (Mak et al., 2003; Sethi et al., 2006; Verhaegh-Haasnoot et al., 2015). In Vancouver, coverage for sex workers as found in the present study is low when compared to vaccination rates for healthcare personnel who face occupational HBV risks related to blood/bodily fluid exposure. It is estimated that 84.3% of such healthcare personnel in Canada have received the HBV vaccination (Government of Canada, 2014), yet only two thirds of sex workers in the present study self-reported ever being vaccinated for HBV at their baseline interview, and only 15% reported recent vaccination during the 7-year study period. Scale-up of voluntary coverage as part of broader efforts to support sex workers' occupational health and safety is recommended. Several sub-populations of sex workers were also identified as facing gaps in HBV vaccination, notably im/migrant women. Women who use drugs and those accessing HIV services and STI testing were more likely to report being vaccinated. Taken together, these findings suggest the need to scale-up voluntary vaccination coverage through culturally safe and community-based programmes, including integration with HIV/STI services. Given extremely limited evidence on HBV vaccination rates amongst sex workers and the elevated STBBI vulnerabilities they face, this study provides a critical first step in understanding the HBV prevention and care needs of sex workers, and is the first study of HBV vaccination amongst sex workers within Canada.

In Canada, provincial/territorial HBV vaccination campaigns targeted at newborns/infants as well as school-aged children have been in place since the early 1990s (Government of Canada, 2016). In BC, free HBV vaccines are provided as part of routine vaccination for infants and school-aged children (sixth grade) who have not

**Table 1**Factors associated with lifetime self-reported hepatitis B vaccination at baseline amongst sex workers in Metro Vancouver, BC (January 2010 to February 2017) (N = 855)<sup>a</sup>.

Characteristic	Lifetime hepatitis B vaccination		OR (95% CI)	p-Value
	Yes n (%) (n = 584)	No n (%) (n = 271)		
<b>Individual-level factors</b>				
Age, median (IQR)	33.5 (27.0–41.0)	36.5 (30.0–43.0)	0.98 (0.96–0.99)	0.005
HIV seropositivity				
Yes	98 (16.8)	22 (8.1)	2.26 (1.39–3.68)	0.001
No	471 (80.7)	239 (88.2)		
Identify as a gender and/or sexual minority <sup>b</sup>				
Yes	212 (36.3)	63 (23.3)	1.87 (1.35–2.60)	<0.001
No	372 (63.7)	207 (76.4)		
Ethnicity				
White	205 (35.1)	70 (25.8)		
Indigenous	240 (41.1)	70 (25.8)	1.17 (0.80–1.71)	0.416
Other minority	136 (23.3)	131 (48.3)	0.35 (0.25–0.51)	<0.001
Any non-injection drug use ever				
Yes	474 (81.2)	162 (59.8)	2.95 (2.14–4.07)	<0.001
No	108 (18.5)	109 (40.2)		
Any injection drug use ever				
Yes	352 (60.3)	95 (35.1)	2.82 (2.09–3.81)	<0.001
No	231 (39.6)	176 (64.9)		
<b>Structural factors</b>				
Im/migrant to Canada				
Yes	119 (20.4)	126 (46.5)	0.29 (0.21–0.40)	<0.001
No	465 (79.6)	143 (52.8)		
Time since migrated to Canada				
Non-migrant	465 (79.6)	143 (52.8)		
Recent migrant	40 (6.9)	51 (18.8)	0.24 (0.15–0.38)	<0.001
Long-term migrant	72 (12.3)	63 (23.3)	0.35 (0.24–0.52)	<0.001
Country of birth				
Canada	465 (79.6)	143 (52.8)		
Non-HBV-endemic country	14 (2.4)	8 (3.0)	0.54 (0.22–1.32)	0.177
HBV-endemic country	104 (17.8)	116 (42.8)	0.28 (0.20–0.38)	<0.001
<b>Healthcare access</b>				
Ever used SRH services in Vancouver				
Yes	272 (46.6)	83 (30.6)	1.98 (1.46–2.68)	<0.001
No	312 (53.4)	188 (69.4)		
Ever had an HCV test				
Yes	468 (80.1)	153 (56.5)	3.59 (2.56–5.05)	<0.001
No	86 (14.7)	101 (37.3)		
Ever had an STI test				
Yes	533 (91.3)	215 (79.3)	2.81 (1.83–4.32)	<0.001
No	45 (7.7)	51 (18.8)		
Ever had an HIV test				
Yes	538 (92.1)	208 (76.8)	3.65 (2.35–5.67)	<0.001
No	39 (6.7)	55 (20.3)		

OR, odds ratio; CI, confidence interval; IQR, interquartile range; HBV, hepatitis B virus; SRH, sexual and reproductive health; HCV, hepatitis C virus; STI, sexually transmitted infection.

<sup>a</sup> All data refer to n (%) of participants, unless specified otherwise. Column percentages may not add up to 100% due to missing data.<sup>b</sup> Defined as 'yes' to any of gay, lesbian, bisexual, queer, two spirit, asexual, transgender, intersex, transsexual, genderqueer, other.

previously been vaccinated ([BC Centre for Disease Control](#)). For the remaining general public, Canada recommends HBV vaccination based on exposures related to medical conditions, occupation, and lifestyle ([Government of Canada, 2012](#)).

Given the median age of participants in this study of 35 years (IQR 28–42 years) and the high prevalence of im/migration from other countries in this cohort, with a median of 6 years (IQR 3–11 years) since migration to Canada, it is likely that many of our

participants may not have benefitted from such population-based efforts (i.e., they were born before 1990 or missed the sixth grade national vaccination programmes). Sex workers also represent a priority occupation group for HBV vaccination ([Government of Canada, 2016](#)), yet unlike healthcare personnel who are also an identified priority ([Government of Canada, 2014](#)), the sex workers in the present study face suboptimal coverage. This is likely due to previously identified barriers to healthcare such as criminalization, stigma, mobility, and unsafe working conditions ([Baars et al., 2009](#); [BC Ministry of Health, 2012](#); [Deering et al., 2015](#); [Magalhães et al., 2017](#)), which make sex workers less likely to disclose their occupation or report potential risk factors to healthcare providers, and thus not meet the criteria for vaccination. In addition, there is an absence of targeted provincial/national HBV vaccination programmes to address HBV risks faced by sex workers in Canada. Although very few settings have explicitly rolled out HBV programmes for sex workers, in the Netherlands where such a campaign exists ([Baars et al., 2009](#)), sex workers still face barriers to care through stigma, mobility, and place of work, all of which affect access to care and vaccinations ([Baars et al., 2009](#); [Magalhães et al., 2017](#)). This emphasizes the need to address broader

**Table 2**

Multivariable logistic regression analysis of factors correlated with lifetime self-reported hepatitis B vaccination at baseline among sex workers in Metro Vancouver, BC (January 2010 to February 2017) (N = 855).

Variable	AOR	95% CI	p-Value
Age	0.98	(0.96–1.00)	0.056
Im/migrant to Canada (Yes vs. no)	0.50	(0.32–0.78)	0.002
Any injection drug use ever (Yes vs. no)	1.88	(1.27–2.78)	0.002
Ever had an HIV test (Yes vs. no)	1.94	(1.14–3.29)	0.014

AOR, adjusted odds ratio; CI, confidence interval.

**Table 3**  
Multivariable GEE analysis of factors longitudinally correlated with recent self-reported hepatitis B vaccination in the last 6 months among sex workers in Metro Vancouver, BC [January 2010–February 2017] (N = 703).

Variable	Adjusted odds ratio (AOR)	95% confidence interval (CI)	p-Value
HIV seropositivity	1.93	(1.26–2.97)	0.003
Had an STI test <sup>a</sup>	2.95	(1.99–4.39)	<0.001

GEE, generalized estimating equations; AOR, adjusted odds ratio; CI, confidence interval; STI, sexually transmitted infection.

<sup>a</sup> In the last 6 months.

determinants of health in order to have a sustained impact on reducing barriers to access and ensuring voluntary and ethical engagement in such public health efforts.

This study demonstrated that im/migrant women who did sex work were significantly less likely to have been vaccinated against HBV in their lifetime, with those from HBV-endemic settings reporting much lower coverage than their Canadian-born counterparts (47.3% vs. 76.4%,  $p < 0.001$ ). In China, the primary country of origin amongst im/migrants in this study, national infant HBV vaccination efforts were not widely implemented until 2002 (Yan et al., 2014; Liao and Liang, 2015); before this, families had to pay for the vaccine themselves, posing barriers to access (Yan et al., 2014). Gaps in current vaccine coverage amongst adults remain, contributing to high prevalence, particularly amongst mobile populations (Yan et al., 2014), and making it likely that many of the Chinese im/migrants in this study were not previously vaccinated. Newcomers to Canada (i.e., permanent/temporary residents and refugees) from HBV-endemic settings are encouraged to receive screening for HBV if they meet additional risk factors (Citizenship and Immigration Canada, 2013). However, due to stigma, criminalization, fear of authorities, and the fact that many participants report initiating sex work post-arrival, it is unlikely that perceived HBV risks would have been reported or adequately addressed through this process. Given this uncertainty surrounding HBV testing for newcomers from HBV-endemic countries, in addition to previously mentioned barriers to healthcare access and support faced by im/migrant sex workers (Anderson et al., 2015; Goldenberg et al., 2017b), there is an urgent need for scale-up of voluntary and culturally safe prevention and outreach for this underserved group.

In BC, best practices for harm reduction recommend that all fixed needle exchange sites provide referrals or direct access to primary healthcare services, including HBV screening and vaccination. There are currently multiple community health centres in Metro Vancouver that follow this model (Vancouver Coastal Health; Vancouver Coastal Health, 2017; BC Centre for Disease Control, 2018). In the present study, sex workers with a history of injection drug use had higher odds of self-reported HBV vaccination, which may be attributed in part to engagement with such integrated services. Additionally, sex workers who had received HIV testing prior to enrolment were more likely to have been vaccinated, and in a sub-analysis, women living with HIV and those accessing recent STI testing were more likely to report recent HBV vaccination over the 7-year study period. These findings taken together suggest that marginalized women accessing HIV-related services, including HIV and STI testing, may be accessing low-barrier healthcare services that facilitate access to prevention and care for viral hepatitis (e.g., HBV, HCV).

This suggests that integrated HIV, STI, and related harm reduction programmes that are appropriately tailored to the needs of marginalized women may be key to facilitating linkage to HBV prevention. Previous research among injection drug users has shown that integrated services, such as combined HIV and HCV testing and counselling, lead to increased disease screening rates and increased provision of vaccination services (Stopka et al., 2007). Additionally, integrated services delivered through

non-traditional methods (e.g., community outreach) allow for low barrier, voluntary engagement (Des Jarlais et al., 2001; Ompad et al., 2004). Integrated community-based outreach has also proven useful for the uptake and completion of the full HBV vaccination schedule (three doses over 6 months) among ‘hard-to-reach’ populations of sex workers when approached within their workplaces (Baars et al., 2009; Carneiro et al., 2014; Magalhães et al., 2017). Current provincial HIV guidelines recommend that HBV vaccination be given to people living with HIV who are susceptible to HBV infection (BC Centre for Excellence in HIV/AIDS, 2015), indicating the critical importance of integrating HBV programmes within harm reduction, sexual health, and HIV initiatives to improve coverage amongst marginalized populations. Finally, the study data were generated in the context of Vancouver’s unique harm reduction programming efforts, where despite significant investments in outreach, harm reduction, and integrated service models, sex workers continue to face gaps in access to equitable and appropriate sexual health, HIV, and harm reduction services and support.

#### Limitations

Several limitations should be considered when interpreting the study data. The measures of lifetime and recent HBV vaccination are self-reported measures, which may be subject to recall and/or social desirability bias. The team of experiential and community-based frontline staff was trained in approaches to mitigate this, including emphasizing the confidential nature of the data, and the use of non-stigmatizing interview techniques. The measure of lifetime and recent HBV vaccination also did not evaluate whether participants had received all three doses of the vaccine; therefore, the findings may overestimate vaccination coverage. Future studies should build on these findings by triangulating questionnaire data with serological and in-depth interviews to elicit information on recent barriers and facilitators to HBV vaccination. HBV serology should be considered for future studies and interventions in order to more accurately identify and treat HBV among sex workers and other marginalized populations. Cross-sectional data are limited in their capacity to imply directionality of findings; however, taken together with community reports and findings of the GEE analysis suggesting associations between HBV vaccination, STI testing, and living with HIV, we are fairly confident that HBV vaccination accessed within or by referral from HIV and STI services are a plausible explanation for some of the observed associations. Finally, although the findings may not be generalizable/representative of all populations of women sex workers due to context-specific social and political factors, this study was based on rigorous community mapping and time-location sampling procedures to ensure a diverse and large sample of sex workers across diverse sex work environments and neighbourhoods of Metro Vancouver.

#### Conclusions

The findings of this 7-year community-based cohort study highlight serious gaps in HBV vaccination coverage for women sex

workers in Metro Vancouver. Im/migrant sex workers, primarily from HBV-endemic settings, are more likely to report not being vaccinated against HBV, revealing the critical need for more targeted occupational interventions to promote voluntary and culturally safe access to vaccinations. Study participants who reported any lifetime injection drug use, or HIV testing were more likely to self-report HBV vaccination, suggesting that harm reduction and HIV programmes may facilitate linkage to HBV prevention. There is very little research looking at implementation of HBV prevention and care among sex workers, but existing literature from other settings suggests that integrated, community-based outreach methods may be most effective at increasing access to voluntary HBV vaccination as well as ancillary services among sex workers (Baars et al., 2009; Magalhães et al., 2017).

Further research and public health efforts incorporating serological HBV testing and vaccination amongst sex workers, particularly im/migrants, is critically needed.

### Ethical approval

All procedures performed in studies involving human participants were conducted in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

### Informed consent

Informed consent was obtained from all individual participants included in the study.

### Conflict of interest

Anuisa Ranjan, Kate Shannon, Jill Chettiar, Melissa Braschel, Lianping Ti, and Shira Goldenberg declare that they have no conflict of interest.

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